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Cognitive defusion and guided imagery tasks reduce naturalistic food cravings and consumption: A field study

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Abstract

The present study investigated the effect of two craving reduction techniques, namely, cognitive defusion and guided imagery, on naturalistic food cravings. These techniques targeted the intrusion and elaboration stages of the craving process, respectively (Kavanagh, Andrade, & May, 2005). Participants underwent a seven-day baseline period followed by a seven-day intervention period, during which they recorded their food cravings as they occurred using online diaries accessed via smartphone. In the intervention period, participants were randomly assigned to one of cognitive defusion, guided imagery or control conditions. Participants in the cognitive defusion and guided imagery conditions listened to three-minute audio clips containing their respective instructions every time they experienced a food craving, and rated their craving intensity before and after the intervention, while the control participants recorded their cravings as they did in the baseline week. Results showed that both cognitive defusion and guided imagery techniques reduced craving frequency, intensity, the likelihood of consumption following cravings, and craving-related calorie intake, consistent with predictions. These findings show that cognitive defusion and guided imagery are useful for dealing with naturally occurring cravings across a range of foods, and can reduce craving-related consumption in everyday life.

Keywords

Food cravings, consumption, cognitive defusion, decentering, guided imagery, Elaborated-Intrusion Theory, online diary

Introduction

Food craving is defined as the intense urge or desire to consume a specific food that is difficult to resist (Weingarten & Elston, 1990). Whereas hunger can be satisfied by consuming food in general, cravings are usually satisfied only by consuming the specific craved food (Pelchat, 2002). Food cravings have been associated with negative mood and depression (Davis et al., 2011), binge eating (Gendall, Joyce, Sullivan, & Bulik, 1998; Waters, Hill, & Waller, 2001) and feelings of guilt. Certain sub-groups such as people who are overweight or obese, or people with binge-eating disorder, can be particularly vulnerable to food cravings (Davis et al., 2011; von Deneen & Liu, 2011; Wurtman & Wurtman, 1986). However, food cravings are a general phenomenon experienced not only by overweight and obese individuals, but also by individuals of healthy weight (Hofmann, Baumeister, Förster, & Voh, 2012). In such individuals, calorie intake following cravings could have a cumulative effect and thus lead to weight gain over time. In support, Boswell and Kober (2016) demonstrated that cravings significantly predicted eating and weight gain in people who are lean, as well as in overweight and obese individuals. Therefore, it is important to develop and test strategies which can reduce cravings and associated consumption.

The Elaborated-Intrusion Theory of Desire suggests that cravings develop in two distinct stages (Kavanagh, Andrade, & May, 2005; May, Andrade, Kavanagh, & Hetherington, 2012). First, initial craving-related thoughts or intrusions may be triggered by food cues in the environment, or other thoughts or memories. Second, these intrusions are then elaborated with vivid mental imagery, which may include visual, olfactory and gustatory features. For example, an individual may experience a seemingly automatic thought about a craved food such as chocolate, and then begin to mentally picture how that chocolate looks, smells or tastes. The craving may continue to grow in intensity and the individual may also develop negative emotions as they become aware of the absence of the craved food. This may

spur more intrusions about the desired target and contribute to a developing cycle of intrusions and elaborations, which can become a progressively more negative affective experience. Usually, cravings are alleviated by giving in to the craving and eating the craved food. Based on the Elaborated-Intrusion theory, May et al. (2012) suggest that craving reduction techniques could target either the intrusion or elaboration stage of the craving process.

A growing body of literature has used mindfulness-based techniques to target food cravings (Alberts, Mulkens, Smeets, & Thewissen, 2010; Forman et al., 2007; see Tapper, 2018 for a review). May et al. (2012) have suggested that mindfulness techniques may change individuals' responses to intrusions, prevent craving-related elaborations and therefore reduce craving frequency. Cognitive defusion, or decentering, is a specific mindfulness-based strategy which teaches individuals to accept their thoughts without trying to banish or challenge them, or automatically act upon them (Blackledge, 2007; Masuda, Hayes, Sackett, & Twohig, 2004). When applied to food cravings, cognitive defusion could target intrusions in the first stage of craving to change individuals' interpretations of their craving-related thoughts and promote more conscious, thoughtful behaviour which better aligns with long-term health goals (Forman et al., 2007). Experimental studies have shown that cognitive defusion tasks can reduce cravings for a range of unhealthy foods (Alberts et al., 2010; Papies, Pronk, Keesman, & Barsalou, 2015). In addition, several field studies showed that cognitive defusion can reduce state and trait chocolate cravings (Lacaille, Zacchia, Bourkas, Glaser, & Knäuper, 2014), and craving-related chocolate consumption (Hooper, Sandoz, Ashton, Clarke, & McHugh, 2012; Jenkins & Tapper, 2014; Moffitt, Brinkworth, Noakes, & Mohr, 2012). However, it is not known whether cognitive defusion can also be used for naturalistic cravings for foods other than chocolate.

Techniques have also been developed to target the second mental imagery stage of craving (May et al., 2012). Imagery-based techniques are designed on the premise that working memory capacity is limited, so that craving-related imagery can be replaced by alternative imagery (Harvey, Kemps, & Tiggeman, 2005; Kemps & Tiggemann, 2007; Versland & Rosenberg, 2007). Guided imagery is one technique in which individuals are instructed to generate an alternative imagery-based scenario such as a walk through a forest or on a beach. This technique incorporates multi-sensory imagery cues to mirror the range of sensory features in craving-related imagery. Guided imagery has been used to combat experimentally-induced cravings for breakfast and snack foods in a series of laboratory-based studies (Hamilton, Fawson, May, Andrade, & Kavanagh, 2013; May, Andrade, Batey, Berry, & Kavanagh, 2010). Other imagery-based tasks (e.g., imagining alternative imagery, playing Tetris or watching dynamic visual noise) have been shown to reduce naturally occurring cravings for a range of substances, including food in the field (Kemps & Tiggemann, 2013; Knäuper, Pillay, Lacaille, McCollam, & Kelso, 2011; Skorka-Brown, Andrade, & May, 2014; Skorka-Brown, Andrade, Whalley, & May, 2015). While Kemps and Tiggemann (2013) found that dynamic visual noise reduced consumption, Skorka-Brown et al. (2015) and Knäuper et al. (2011) did not find effects of other imagery-based techniques on consumption. Skorka-Brown et al. (2015) argued that the participants in their unselected sample may not have been motivated to resist their desires, but Knäuper et al.'s (2011) sample consisted of individuals who wished to reduce their craving-related consumption. In light of these mixed results, we sought to further explore whether reductions in craving intensity result in reductions in related consumption. Our overarching aim was to compare the efficacy of cognitive defusion and guided imagery as craving reduction techniques in the field.

One laboratory-based paper (Schumacher, Kemps, & Tiggemann, 2017) has specifically tested whether cognitive defusion and guided imagery techniques alter the two theoretical stages of the craving process they are thought to target (May et al., 2012) in a general sample (Experiment 1) and in regular chocolate cravers (Experiment 2). A combination of chocolate deprivation and exposure was used to induce chocolate cravings. As predicted, cognitive defusion reduced the intrusiveness of thoughts, guided imagery reduced the vividness of imagery, and both techniques reduced overall intensity of chocolate cravings. However, contrary to prediction, neither technique affected the consumption of chocolate in a laboratory-based taste test. This adds to the uncertainty in the literature about whether reducing cravings leads to reductions in craving-related consumption.

The current field study was designed to extend the previous literature by testing the relative effect of cognitive defusion and guided imagery on naturalistic food cravings and resultant consumption outside the laboratory. First, we aimed to test the effectiveness of the techniques for cravings for a range of foods, not just chocolate. Second, we wished to test the techniques in the field, where individuals experience naturally occurring cravings, along with ample consumption opportunities. An online diary was used so that participants could record their cravings as they occurred in real-time, with diaries available on mobile platforms. We collected baseline data in Week 1 with which to compare the effects of the interventions implemented in Week 2. We also incorporated a control condition. We predicted that participants who used cognitive defusion or guided imagery would report fewer cravings of lower intensity. We further predicted that participants in the cognitive defusion and guided imagery conditions would be less likely to eat in response to their cravings, and consequently would consume fewer craving-related calories than those in the control condition.

Method

Participants

Participants were 127 women who were recruited from the Flinders University student population, and from the wider Adelaide community. Following the protocol of Kemps and Tiggemann (2013), we specifically recruited participants who reported experiencing at least one food craving per day**.** Recruitment targeted women because they tend to experience more frequent cravings than men (Weingarten & Elston, 1991). To participate, women had to have access to a smartphone, and could not be pregnant. During the baseline week (Week 1), 9 participants declined to continue in the study, which left 118 women aged 17-53 years (M = 21.96, SD = 7.45) who completed the full two weeks of the study. Data are reported for the 118 completers. According to Cohen's (1992) guidelines, this sample size is sufficient to detect a moderate to large effect at 0.80 power, with an alpha of 0.05 (Cohen, 1992). Prior to Week 1, participants reported a mean of 1.32 food cravings per day (SD = 1.14). Approximately half of the participants (47.4%) reported that they were on a diet to lose weight or were watching what they ate in order to not put on weight. Mean BMI of the sample was 23.36 kg/m^2 (SD = 5.25), which is considered to be in the healthy weight range (WHO, 2017). Using BMI weight categories for classification, 11.9% of participants were classified as underweight (BMI of <18.5), 60.2% were in the healthy weight range (BMI of 18.5-24.9), 12.7% were overweight (BMI of 25-29.9) and 15.3% were obese (BMI >30).

Design

The study used a 3 (condition: cognitive defusion, guided imagery, control) x 2 (time: Week 1 (baseline), Week 2 (intervention)) mixed factorial design where condition was the between-subjects factor and time was the within-subjects factor. Outcome variables were craving frequency, intensity, percentage of cravings followed by consumption and craving-related calories consumed. Participants were allocated to the three conditions: cognitive

defusion (n = 42), guided imagery (n = 39) or control (n = 37), at the beginning of Week 2 according to a pre-determined counterbalanced appointment schedule.

Materials and Procedure

The first week (Week 1) of the study served as a baseline, during which participants recorded their food cravings and craving-related consumption. The intervention took place in the second week. During Week 2, participants in the control condition continued to report their cravings and consumption as in Week 1. Participants in the cognitive defusion and guided imagery conditions were asked to listen to and use techniques delivered as three-minute audio guides every time they experienced a food craving.

Throughout the two-week study period, participants recorded their food cravings and consumption using an online self-report diary. The online diary was designed using Qualtrics, and adapted for use on mobile platforms. Participants were able to access their online diaries wherever they were, using their personal smartphones, laptops, desktop computers or tablets. Participants accessed the diaries using a hyperlink, which was sent along with a reminder each day. Reminders were sent via text message or email (according to preference) at 11:00am each day. Participants were instructed to make a record whenever they experienced a craving, rather than at specific times throughout the day. This meant that multiple entries were made if a participant had multiple cravings. If a participant did not have a craving, they did not make an entry.

Diary content was adapted from the paper diaries used by Kemps and Tiggemann (2013). Participants were first asked to report the food they craved. Next, they were asked to rate the intensity of the craving on a 100mm visual analogue scale ranging from ‘not at all intense’ to ‘extremely intense’. Participants then reported whether or not they ate in response to the craving with a ‘Yes/No’ response. These responses were used to calculate the percentage of cravings followed by consumption. If participants selected the ‘Yes’ response,

they were asked to report what and how much they ate. Participants were instructed to specify the brand of food and portion size (e.g., small bowl or grams/millilitres) where possible. Responses were converted to calories using the calorie guide websites, My Fitness Pal and Calorie King (My Fitness Pal, 2018; Calorie King, 2018). If participants did not report the serving size, standard serving sizes were used. The number of calories consumed per craving (including episodes where cravings were resisted) and per consumption episode (only cravings which were indulged) were calculated, as well as the total number of craving-related calories consumed for the week.

At the beginning of the baseline week (Week 1), participants attended a brief information session, which took place in the Applied Cognitive Psychology Laboratory. During this session, participants were given information about the study procedure. They also completed an example of the food craving diary. Once the session had ended, participants were instructed to complete their online diaries for one week, recording their cravings as often as they occurred with the help of their daily reminders.

After participants had completed Week 1 of the online diaries, they attended a second information session where they were given instructions about how to complete the diaries in the second week (intervention). Participants in the control condition were instructed to continue reporting their cravings and consumption as they had done in the first week. Participants in the cognitive defusion and guided imagery conditions were instructed to complete intervention diaries which involved using a brief technique. To create the technique audio guides, the experimenter voice-recorded instructional statements in three-minute clips, and then embedded these in the diaries (statements were adapted from those used in Schumacher et al., 2017, with guided imagery script originally from May et al., 2010; see Appendix A for experimental scripts).

Participants using the cognitive defusion technique were asked to listen to and follow instructions which asked them to pay attention to and create distance between themselves and their thoughts (e.g., 'Notice the thoughts you are having now. Take a moment to step back from them, viewing them as merely thoughts'). Content also covered distinguishing thoughts from facts, and increasing awareness of the automaticity of thought and behaviour patterns. Participants in the guided imagery condition were told to listen to instructional statements which led them through an imaginary walk through a forest. Participants were asked to create mental imagery depicting sights, sounds, smells and sensations associated with being in a forest (e.g., 'You can smell the damp earth and can see a haze of blue in the distance. You feel the twigs breaking under your feet'). A range of multi-sensory cues were deliberately used in the instructions to encourage the generation of alternate forest-related imagery that had similar sensory features to craving-related imagery. No reference to food or cravings was made in either technique clip. Participants were not able to skip through the audio clip, and were instructed to listen to and carefully follow the instructions throughout the clip. Participants reported whether they had followed instructions with a 'Yes/No' question immediately following the audio clip (participants responded 'Yes' on 80.7% of occasions). Participants in the cognitive defusion and guided imagery conditions rated their craving intensity immediately before and after using the technique. Aside from these changes, the diaries were the same as in Week 1.

Results

Statistical analysis

To determine significance, an alpha level of 0.05 was used. For measuring effect size in Analysis of Variance (ANOVA), partial eta-squared was used, with 0.01 representing a small effect, 0.06 a moderate effect and 0.14 a large effect. For *t*-tests, Cohen's *d* was used, with benchmarks at 0.20 for small, 0.50 for moderate and 0.80 for large effects. A series of 3

(condition: cognitive defusion, guided imagery, control) x 2 (time: Week 1, Week 2) mixed factorial ANOVAs was conducted to assess the effect of the interventions on craving frequency, percentage of cravings followed by consumption, craving-related calorie intake and total craving-related calorie intake. Within-condition change for the intervention conditions was assessed using EMMEANS. Finally, orthogonal planned comparisons were conducted to compare the change scores in the cognitive defusion and guided imagery combined and the control condition, and against each other.

Sample characteristics

Table 1 shows the baseline characteristics of the sample. During Week 1, cravings were most common for chocolate (25.3%; e.g., chocolate, chocolate cake), followed by savoury meals (17.2%; e.g., cheese, roast dinner, seafood), sweet foods (16.5%; e.g., cakes, doughnuts, ice-cream), and takeaway foods (13.9%; e.g., pizza, burgers, fries). All participants reported at least one craving per week. The number of cravings reported ranged from 1 to 34 in Week 1 (M = 7.83, SD = 4.82) and 1 to 17 in Week 2 (M = 3.99, SD = 2.77).

Effect of interventions on cravings

Craving frequency. Analyses showed no main effect of condition, $F(2, 115) = 1.46$, $p = .237$, $\eta_p^2 = .025$ (small effect). There was, however, a significant main effect of time, $F(1, 115) = 106.93$, $p < .001$, $\eta_p^2 = 0.482$ (large effect), and a condition x time interaction, $F(2, 115) = 4.19$, $p = .018$, $\eta_p^2 = 0.068$ (moderate effect). As shown in Figure 1, craving frequency reduced from Week 1 to Week 2 following both cognitive defusion ($|M_{difference}| = 4.57$, $p < .001$, $d = 1.12$) and guided imagery ($|M_{difference}| = 4.54$, $p < .001$, $d = 1.04$), both with large effect sizes. Orthogonal planned comparisons confirmed that although craving frequency also declined in the control condition from Week 1 to Week 2 ($|M_{difference}| = 2.27$, $p = .001$, $d = 0.74$; moderate effect), this was to a significantly lesser extent than in the experimental conditions combined, $t(115) = 2.89$, $p = .005$, $d = 0.58$, showing a moderate sized difference.

Each of cognitive defusion and guided imagery were individually different from the control condition (cognitive defusion $t(77) = 3.44$, $p = .001$, $d = 0.78$; guided imagery $t(74) = 2.30$, $p = .024$, $d = 0.53$), with no difference between them, $t(115) = 0.04$, $p = .970$, $d = 0.01$.

Craving intensity. During the intervention period (Week 2), participants in the cognitive defusion and guided imagery conditions rated their craving intensity on each occasion immediately before and after using the respective technique. The control condition continued to rate their craving intensity once per occasion, as they had done in Week 1. Craving intensity means were calculated for each participant across the week. Paired samples *t*-tests showed that there was a significant reduction in craving intensity after completing the cognitive defusion task ($M = 42.49$, $SD = 19.94$) compared to before ($M = 62.37$, $SD = 17.71$), $t(39) = 6.59$, $p < .001$, $d = 1.05$ (large effect). There was a similar reduction in craving intensity for participants in the guided imagery condition (before: $M = 60.94$, $SD = 14.05$, after: $M = 46.76$, $SD = 17.41$), $t(38) = 6.51$, $p < .001$, $d = 0.90$ (large effect).

Two one-way ANOVAs were used to test whether both the pre- and post-intervention craving intensity ratings of the experimental conditions differed from the single-item craving intensity measure of the control condition. Results showed that the pre-intervention ratings in the cognitive defusion ($M = 63.40$, $SD = 18.19$) and guided imagery conditions ($M = 60.94$, $SD = 14.05$) did not differ from the control condition rating ($M = 67.97$, $SD = 16.60$), $F(2, 117) = 1.79$, $p = .172$, $\eta^2 = .030$ (small effect). In contrast, the post-intervention ratings significantly differed from the control condition rating, $F(2, 113) = 21.59$, $p < .001$, $\eta^2 = .276$ (large effect). Post-intervention ratings in the cognitive defusion ($\boldsymbol{M} = 42.49$, $SD = 16.60$) and guided imagery ($M = 46.76$, $SD = 17.41$) conditions were not significantly different, $t(77) = 1.01$, $p = .314$, $d = 0.25$ (small effect).

Effect of interventions on craving-related consumption

Percentage of cravings followed by consumption. Results showed significant main effects of condition, $F(2, 115) = 3.63$, $p = .029$, $\eta_p^2 = 0.059$ (moderate effect), and time, $F(1, 115) = 35.18$, $p < .001$, $\eta_p^2 = 0.234$ (large effect). The condition x time interaction fell just short of significance, $F(2, 115) = 2.83$, $p = .063$, $\eta_p^2 = 0.047$ (small effect). As can be seen in Figure 2 and following predictions, participants in the cognitive defusion condition ate significantly less often in response to their cravings in Week 2 than in Week 1 ($|M_{difference}| = 29.72\%$, $p < .001$, $d = 1.03$; large effect). Similarly, participants in the guided imagery condition were less likely to eat in response to their cravings in Week 2 than in Week 1 ($|M_{difference}| = 18.35\%$, $p = .002$, $d = 0.73$; moderate to large effect). In contrast, for control participants, the difference between the percentage of cravings followed by consumption in Week 1 and Week 2 was not statistically significant ($|M_{difference}| = 10.72\%$, $p = .072$, $d = 0.32$; small effect). Orthogonal planned comparisons showed a near significant difference between change scores of the two experimental conditions combined and the control condition, $t(115) = 1.87$, $p = .064$, $d = 0.38$ (small effect), and no significant difference between the two experimental conditions, $t(115) = 1.43$, $p = .156$, $d = 0.32$ (small effect).

Craving-related calorie intake. Analyses of the effect of the interventions on calories consumed per craving occasion (including episodes where participants resisted their cravings) showed significant main effects of condition, $F(2, 115) = 3.73$, $p = .027$, $\eta_p^2 = 0.061$ (moderate effect), and time, $F(1, 115) = 13.09$, $p < .001$, $\eta_p^2 = 0.102$ (moderate effect). The condition x time interaction effect fell just short of significance, $F(2, 115) = 2.92$, $p = .058$, $\eta_p^2 = 0.048$ (small effect). As shown in Figure 3, there was a significant reduction in craving-related calorie consumption per occasion for cognitive defusion from Week 1 to Week 2 ($|M_{difference}| = 77.25$, $p = .003$, $d = 0.65$; moderate effect). Calorie consumption per craving occasion also significantly decreased in the guided imagery condition from Week 1 to Week 2 ($|M_{difference}| = 83.74$, $p = .002$, $d = 0.66$; moderate effect). In contrast, craving-

related consumption per occasion did not significantly differ between Week 1 and Week 2 for the control condition ($|M_{difference}| = 2.38$, $p = .930$, $d = 0.02$). Orthogonal planned comparisons showed a significant difference between change scores in the experimental conditions and the control condition, $t(115) = 2.41$, $p = .017$, $d = 0.48$ (moderate effect), with no difference between cognitive defusion and guided imagery, $t(115) = 0.18$, $p = .858$, $d = 0.05$.

A second ANOVA was conducted to assess the effect of the intervention techniques on calorie intake for the subsample of cravings which were followed by consumption. This analysis excluded 37 participants who successfully resisted their cravings in either Week 1 or 2. The analysis showed no main effect of condition, $F(2, 78) = 1.62$, $p = .204$, $\eta_p^2 = 0.040$ (small effect), time, $F(1, 78) = 0.28$, $p = .601$, $\eta_p^2 = 0.004$, or a condition x time interaction, $F(2, 78) = 1.99$, $p = .144$, $\eta_p^2 = 0.048$ (small effect). There were no significant within-condition changes from Week 1 to Week 2 in any condition; cognitive defusion ($|M_{difference}| = 12.16$, $p = .745$, $d = 0.08$), guided imagery ($|M_{difference}| = 38.32$, $p = .247$, $d = 0.26$; small effect), or control ($|M_{difference}| = 58.36$, $p = .108$, $d = 0.41$; small effect). Orthogonal planned comparisons confirmed that there was no significant difference between the two experimental conditions combined and the control condition, $t(78) = 1.64$, $p = .106$, $d = 0.23$ (small effect), or between cognitive defusion and guided imagery, $t(78) = 1.02$, $p = .313$, $d = 0.14$.

Total craving-related calorie intake. Finally, analyses on the total number of craving-related calories consumed for the week revealed no main effect of condition, $F(2, 115) = 0.91$, $p = .405$, $\eta_p^2 = 0.016$ (small effect), but a main effect of time, $F(1, 115) = 43.57$, $p < .001$, $\eta_p^2 = 0.275$ (large effect). Importantly, there was a significant condition x time interaction, $F(2, 115) = 3.92$, $p = .023$, $\eta_p^2 = 0.064$ (moderate effect). As can be seen in Figure 4, participants consumed significantly fewer craving-related calories in Week 2 than in Week 1 in both the cognitive defusion ($|M_{difference}| = 1048.76$, $p < .001$, $d = 0.78$ (moderate to large effect) and guided imagery conditions ($|M_{difference}| = 1090.23$, $p < .001$, $d = 1.15$; large

effect). However, there was no significant difference between the number of calories consumed in Week 1 and Week 2 for the control condition ($|M_{difference}| = 321.30$, $p = .150$, $d = 0.31$; small effect). Orthogonal planned comparisons confirmed a significant difference between change scores in the control condition and the two intervention conditions, $t(115) = 2.80$, $p = .006$, $d = 0.56$ (moderate effect), and no difference between the interventions, $t(115) = 0.14$, $p = .890$, $d = 0.03$.

Discussion

The main aim of the present study was to test the field application of two craving reduction strategies informed by the Elaborated-Intrusion Theory of Desire (Kavanagh et al., 2005). Specifically, the study compared the efficacy of cognitive defusion and guided imagery as intervention techniques for reducing naturally occurring cravings for food of any kind. The real-world setting also allowed for an ecologically valid measure of consumption. Thus, at any time when a craving arose, individuals could apply their respective technique, with access to the consumption opportunities they would normally face. In line with our predictions, we found that participants who used cognitive defusion or guided imagery experienced reductions in craving frequency and intensity. Importantly, we showed that cognitive defusion and guided imagery reduced the percentage of cravings followed by consumption, as well as the total number of craving-related calories consumed during the week relative to both baseline consumption and to the control condition.

The results showed that both cognitive defusion and guided imagery equally reduced craving frequency from Week 1 to Week 2, and craving intensity within the intervention week, with a large effect size. The observed craving reduction following cognitive defusion fits with previous research which has shown that it is a useful strategy for targeting unwanted chocolate cravings (Jenkins & Tapper, 2014; Lacaille et al., 2014; Moffitt et al., 2012), and extends this to food in general. It provides further confirmation of the conclusion of a recent

review that cognitive defusion is a promising technique in the broader food craving and consumption field (Tapper, 2017).

The observed craving reduction following guided imagery is in line with studies that have used other imagery-based techniques for reducing naturalistic cravings (Kemps & Tiggemann, 2013; Knäuper et al., 2011; Skorka-Brown et al., 2014; Skorka-Brown et al., 2015). In comparing the relative efficacy of cognitive defusion and guided imagery, the present study found that there was no difference between the techniques in their ability to reduce craving frequency, nor intensity. This suggests that they are equally effective for reducing naturally occurring food cravings in everyday settings.

Not only did cognitive defusion and guided imagery reduce craving frequency and intensity, but importantly, the interventions also reduced craving-related consumption. First, orthogonal planned comparisons showed that the craving-related consumption per craving episode was significantly lower in the experimental conditions than the control condition, with a moderately sized effect. Second, although the number of craving-related calories consumed per episode did not differ by condition among those who gave in to their cravings, overall, because participants in the experimental conditions gave in to their cravings less often, they consumed significantly fewer craving-related calories in Week 2 compared with the control condition and Week 1. Together, these results suggest that the cognitive defusion and guided imagery interventions increased participants' ability to resist their cravings.

These novel consumption findings contrast with previous research examining cognitive defusion and guided imagery in a laboratory context (Schumacher et al., 2017), which did not find any effect on consumption. Laboratory studies testing craving reduction strategies often rely on experimentally-induced cravings for a specific food, whereas the present study tested naturally occurring cravings for a range of foods. Moreover, laboratory-based studies typically measure consumption with a single 'taste test', where participants are

required to consume at least some of the food presented (which they may not necessarily like), and may restrict their consumption due to the implicit or explicit presence of the researcher. The current pattern of results suggests that a one-off consumption measure (such as a laboratory taste test) may not afford participants the opportunity to resist their cravings, and thus does not fully represent the effect of the techniques on ongoing naturalistic consumption.

Our results contrast with other field studies that found no effects of other imagery-based techniques on consumption (Knäuper et al., 2011; Skorka-Brown et al., 2015). It is possible that guided imagery may be more effective for reducing craving-related consumption than tasks such as Tetris (Skorka-Brown et al., 2015) or imagining a pleasurable activity (Knäuper et al., 2011) because it is more absorbing, cognitively demanding and structured. Guided imagery requires participants to form mental images that are constantly changing, with continuous prompting which guides individuals from one mental scene to another. Likewise, cognitive defusion is a cognitively demanding and structured task that requires participants to mentally distance themselves from their thoughts in response to prompts. Future research will need to confirm this suggestion by comparing the efficacy of cognitive defusion, guided imagery and other imagery-based techniques. Nonetheless, the current results support the notion that in-the-moment interventions such as cognitive defusion and guided imagery can effectively curb cravings to reduce the likelihood that they will be satisfied, which accumulates to fewer craving-related calories consumed over time.

The present study has several theoretical and practical implications. Theoretically, the results provide additional support for craving reduction techniques developed within the context of the Elaborated-Intrusion Theory of Desire (Kavanagh et al., 2005). Cognitive defusion is a technique thought to target the intrusion stage of the craving process. Guided imagery is a technique designed to target the elaboration stage. Here we showed that both

techniques were successful in reducing naturalistic craving frequency, intensity and consumption, suggesting that targeting either the intrusion stage or the elaboration stage disrupts the craving process, as the theory would predict.

Practically, the major contribution of the present study is that the techniques not only reduced craving frequency and intensity, but also consumption. While the reduction in calorie intake per occasion did not differ by condition, both cognitive defusion and guided imagery more than halved the total number of additional craving-related calories consumed, amounting to over 1000 fewer calories per week. This reduction in craving-related consumption has potential implications for substantial cumulative reductions in calorie intake over weeks, months and years, and is consistent with Boswell and Kober's (2016) findings that food cravings predict weight gain. Further, the versions of the techniques we developed are easy to use and readily accessible via mobile phone or tablet. Such forms of intervention carry the advantage that they can be used discreetly in-the-moment, and can provide support anytime and anywhere.

Despite its methodological strengths, the current study also has a number of limitations. First, we used a passive control condition with which to compare the experimental techniques. An active control task should be used in future research to discriminate the effect of the experimental techniques from outcomes due to other factors. Second, our control condition only rated craving intensity at a single time point, whereas the experimental conditions had pre- and post-intervention craving intensity measures. Third, although participants were instructed to report their craving-related consumption with as much detail as possible, sometimes they did not do so, in which case responses had to be coded according to standard serving sizes. Finally, although participants in the experimental conditions reported that they had used the technique most of the time (80.7%), there was no

way in which to assess the extent to which they had followed the instructions and attended to the content of the audio clip on each occasion.

In conclusion, the present study has shown that cognitive defusion and guided imagery can reduce food craving frequency and intensity, and importantly, craving-related consumption. We extended previous evidence to show that these techniques can be used successfully for naturalistic food cravings in the participant's own environment. The interventions were brief and easily accessible for in-the-moment use. Future research should test their effectiveness for individuals who suffer from problematic cravings and unwanted over-consumption of food.

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Table 1

Means (and standard deviations) for baseline (Week 1) characteristics of sample, with oneway ANOVA results for between group differences.

	Cognitive Defusion	Guided Imagery	Control	*F*	*p*
Age	22.51 (9.17)	21.08 (4.59)	22.29 (7.81)	0.41	.67
BMI (kg/m^2)	22.28 (4.53)	23.26 (4.62)	24.75 (6.39)	2.15	.12
Number of cravings	7.76 (4.90)	8.92 (5.77)	6.76 (3.25)	1.96	.15
Craving intensity	62.56 (14.81)	58.21 (13.47)	61.22 (16.39)	0.89	.41
% cravings followed by intake	58.84	59.52	60.50	0.45	.63
Calories consumed (satisfied cravings only)	309.19 (227.61)	298.08 (256.05)	327.73 (250.90)	0.94	.39

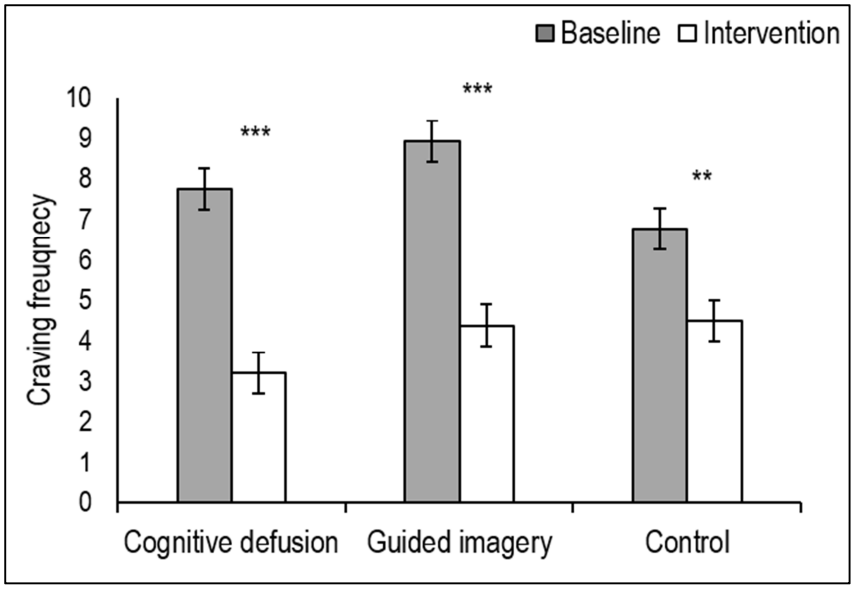

Figure 1. Craving frequency for baseline (Week 1) and intervention (Week 2) by condition. Within-subjects 95% confidence intervals (± 0.51) shown (Masson & Loftus, 2003). NB. * $p < .05$, ** $p < .01$, *** $p < .001$.

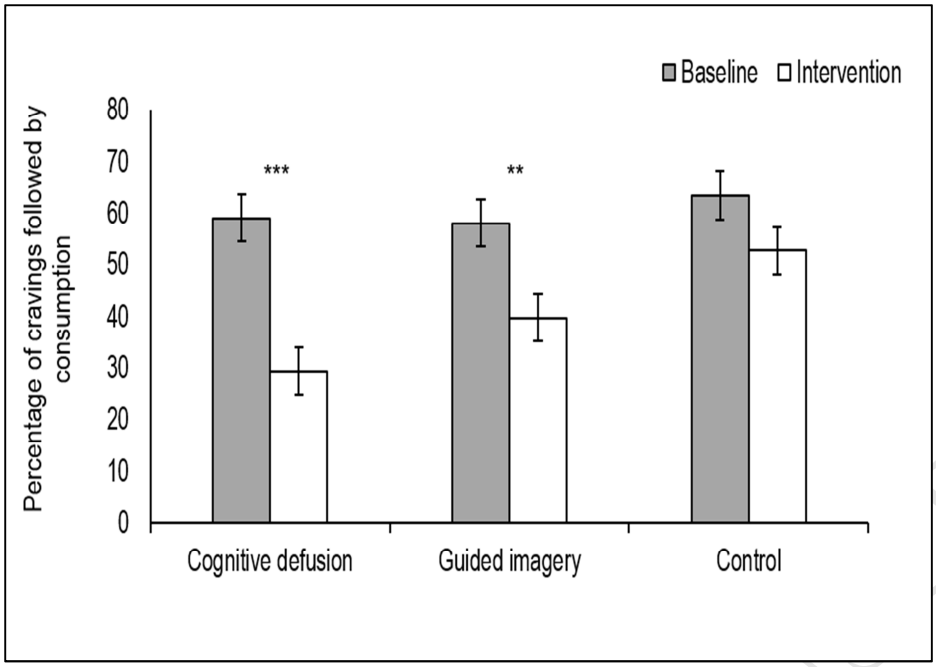

Figure 2. Percentage of cravings followed by consumption for baseline (Week 1) and intervention (Week 2) by condition. Within-subjects 95% confidence intervals (± 4.62) shown (Masson & Loftus, 2003). NB. * $p < .05$, ** $p < .01$, *** $p < .001$.

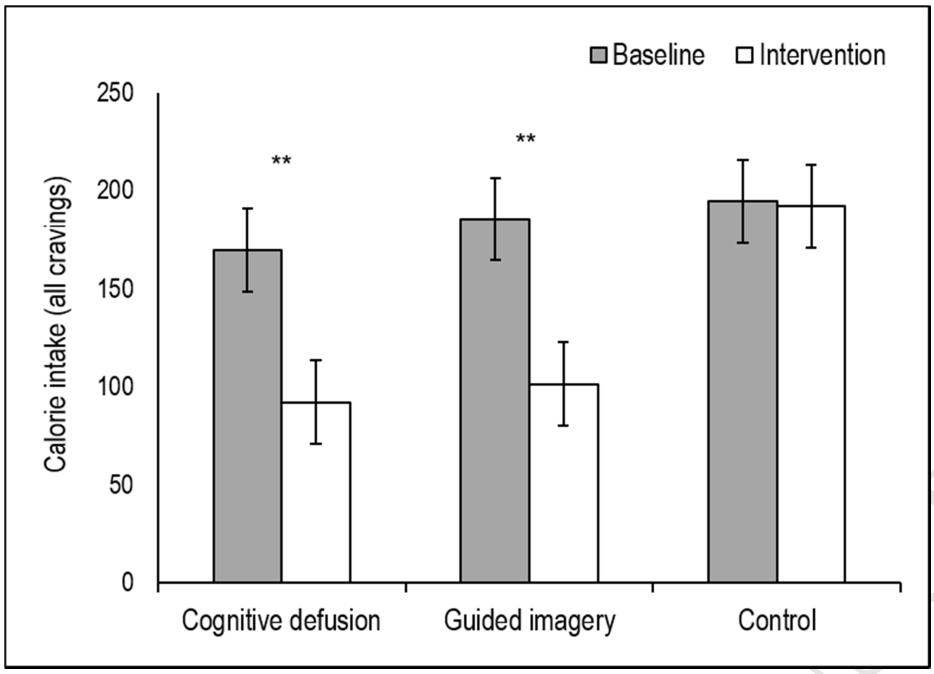

Figure 3. Mean calories consumed (all craving episodes), for baseline (Week 1) and intervention (Week 2) by condition. Within-subjects 95% confidence intervals (± 21.05) shown (Masson & Loftus, 2003). NB. * $p < .05$, ** $p < .01$, *** $p < .001$.

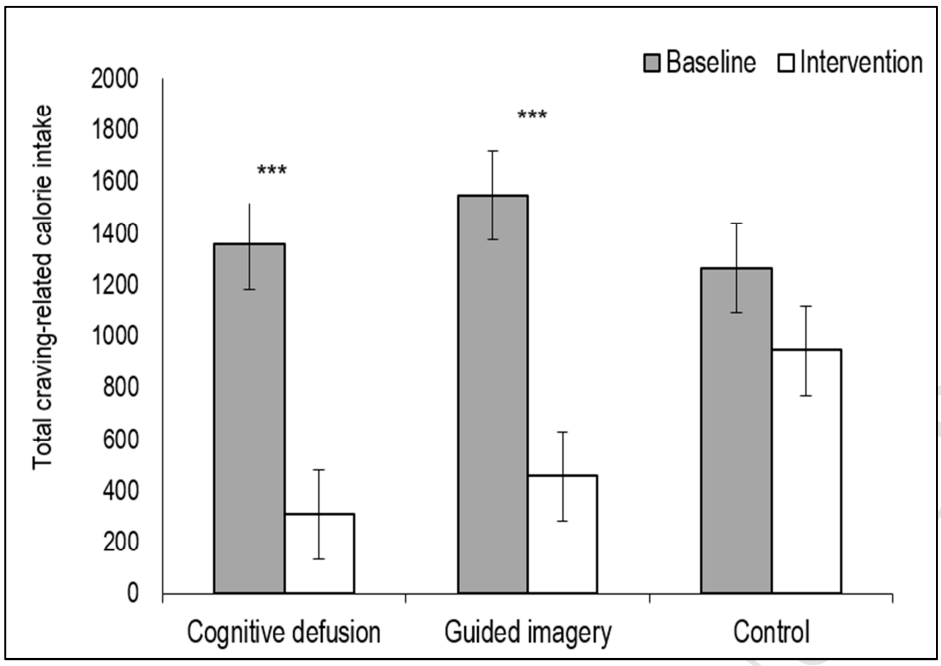

Figure 4. Total craving-related calorie intake for baseline (Week 1) and intervention (Week 2) by condition. Within-subjects 95% confidence intervals (± 173.78) shown (Masson & Loftus, 2003). NB. * $p < .05$, ** $p < .01$, *** $p < .001$.

Appendix A

Cognitive defusion script. Now that your headphones have been fitted comfortably, please close your eyes. Sitting on your chair, feet flat on the floor and hands resting in your lap. Focus on your breath, feeling how the air moves in and out of your body. You may feel sensations in your body, notice them but allow them to pass. Notice any thoughts that come to your mind, staying within the present moment. Try to focus all of your attention on any thought you have in mind. Sometimes, we are able to see thoughts more clearly if we take a step back from them.We can become fused to our thoughts, when we believe our thoughts to be true without questioning them. But this is not always the case. Sometimes it is useful to take a step back from your thoughts, to consider whether they align with your goals, values and beliefs. It can be helpful to think of yourself as different or separate to your thoughts. They are creations of your mind, and can sometimes be different to your intentions. Sometimes we believe that thoughts are causal to actions, that because our thoughts are true, we must act on them. But this is not always the case. Notice the thoughts you are having now. Take a moment to step back from them, viewing them as merely thoughts. When you become more aware that you are having a thought, you will notice that it will soon fade, similar to the way leaves might float away on a stream. Whatever thoughts you are having at this moment, stay present with them. Do not try to change or challenge them, just let them exist. Consider your thoughts as merely thoughts, and do not judge them. If you sit with your thoughts, you will be able to ride them like a wave, even if they become stronger and more powerful, eventually they will fade. You are in control of your actions, and you do not need to act on your thoughts. You are in charge of your own thoughts, just like you are separate from them. You can decide whether you will act on them or not. Notice any thoughts you are

having at this moment. Step back from them and view them for what they are, just thoughts. Focus your attention again on your breathing. Notice the way your breath moves in and out of your lungs. And when you feel ready, open your eyes and once again take in the room.

Guided Imagery Script (adapted from May et al., 2010). Now that your headphones have been fitted comfortably, please close your eyes. Sitting on your chair, feet flat on the floor and hands resting in your lap. I want you to imagine that you are walking along the edge of a field towards a small forest just ahead of you. The sun is out and the air is bright and fresh. You walk into the forest along a narrow path between the trees. The forest is composed of many kinds of trees. The trees extend their leafy branches down to the earth. The branches of the trees wave towards you. Brightly coloured birds call from the forest, their voices rising and fading. Thousands of shades of green moss carpet the ground beneath the trees. Sunlight plays with the leaves and casts shadows on the path. You can smell the damp earth and can see a haze of blue in the distance. You feel the twigs breaking under your feet. Look up to see bits of the blue sky through the tops of the trees. Catch glimpses of birds as they fly from one tree to the next. In front of you a winding path leads uphill through the trees. Feel the path beneath your feet as you travel through the forest. The trees become denser and the air becomes cooler. It becomes darker as the trees grow closer together. You can see blue sky through the trees. All around you are flowers, bobbing their heads in the breeze. The scent of the flowers wafts around you. Ahead of you is a large log that has fallen and settled in the middle of the forest. You sit on the log and look around you at the forest, run your hand along the branch, feeling the contours of the rough, old bark. Small forest animals are going about their daily business, unaware of your presence. A brightly coloured bird comes close and you can see the green feathers of his chest. Further away you see beetles and ants scurrying along. The branches of the trees make strange shapes against the sky. There are sounds of bird song and the breeze in the tree branches. You can hear a stream

running past somewhere nearby. The sounds of the forest are all around you. When you feel ready, open your eyes and once again take in the room.